Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's	)	RM No. 9165
Rules to Incorporate Mobile Earth	)	
Station Out-of-Band Emission Limits	)	

COMMENTS OF COMSAT CORPORATION

COMSAT Corporation ("COMSAT"), by its attorney, hereby files its comments on the Petition for Rulemaking filed by the National Telecommunications and Information Administration ("NTIA") in the above-captioned docket.[1]

I. Introduction and Summary

NTIA has filed this Petition to request that the Commission modify its rules by incorporating out-of-band emission limits for Mobile Earth Terminals ("METs") to protect GPS and GLONASS satellite radionavigation systems operating in the 1559-1610 MHz band. According to NTIA, it will be necessary to limit the out-of-band ("OOB") emissions of METs to -70 dBW/MHz for wide band emissions and -80 dBW/700 Hz for narrow band emissions in the band 1559-1585.42 MHz for the protection of GPS. Protection of GLONASS would be ensured by requiring that all MSS equipment operating in the 1610-1660.5 MHz band commissioned after January 1, 2002 or in operation after January 1, 2005 meets the prescribed limits in the band

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[1] In the Matter of Amendment of the Commission's Rules to Incorporate Mobile Earth Station Out-of-Band Emission Limits, Petition for Rulemaking of United States Dept. of Commerce, National Telecommunications and Information Administration, RM No. 9165 (Sept. 23, 1997) ("Petition").

1559-1605 MHz.[2] "In the meantime, MSS terminals would be allowed to operate with the higher OOB emission levels."[3] According to the Petition, this approach "is acceptable to NTIA, FAA and Globalstar."[4]

COMSAT, as the U.S. Signatory to the International Mobile Satellite Organization ("Inmarsat"), is a global provider of mobile satellite services and thus has a significant interest in the outcome of this proceeding. COMSAT provides maritime, land mobile, and aeronautical satellite communications services using Inmarsat space segment to customers throughout the world, who access COMSAT's services using a variety of Inmarsat mobile terminals. The Inmarsat terminals transmit in the 1626.5-1660.5 MHz band and, as such, would be required under the NTIA proposal to meet the proposed limits for GPS immediately and for GLONASS by January 1, 2005 (except terminals commissioned after January 1, 2002, which would have to meet the proposed limits for GLONASS upon commissioning).

The oldest of the Inmarsat terminals is the Standard-A. This is an analog terminal used for voice, telex, data, and fax services. Although Standard-A is Inmarsat's oldest terminal, with no type approvals of new designs since 1989, it continues to be used by a wide variety of customers, including many government customers, who value its proven reliability and signal quality. The

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[2] Additionally, METs commissioned prior to January 1, 2002 that operate in the 1610-1626.5 MHz band will be required to meet OOB limits of -64 dBW/MHz for wide band signals in the 1580.42-1605 MHz band and -74 dBW/700 Hz for narrow band signals in the 1585.42-1605 MHz band for the protection of GLONASS as well. Because Inmarsat terminals do not operate in this band (use of these frequencies is limited to the Big LEOs), COMSAT does not express an opinion on this proposal.

[3] Petition enclosure, Summary.

[4] Petition ¶ 1.

Standard-B terminal provides the same services as Standard-A, but using digital, rather than analog, technology. The Standard-C terminal provides digital store-and-forward service for data and telex. Its uses include, among other things, e-mail, weather and news services, and automatic forwarding of GPS position information. The Standard-M terminal is a suitcase-sized digital terminal for voice, low-speed data, and fax communications. Mini-M is a digital terminal that provides the same services as Standard-M, but in a notebook-sized unit weighing less than six pounds. Finally, Inmarsat Aero terminals provide in-flight voice, fax, and data services to passengers, pilots, and crew aboard commercial, government, and corporate aircraft.

While the mobile earth terminals operating with the Inmarsat system should have no difficulty meeting the proposed limits for the protection of GPS, it is COMSAT's belief that there is no technical reason that NTIA's proposed GLONASS protection limits should apply to maritime-based terminals. All maritime-based terminals should therefore be excluded from the GLONASS limits entirely. With regard to land-based terminals, it is likely that Inmarsat's digital terminals -- B, C, M, and mini-M -- will be able to meet the GLONASS limits, but land-based Inmarsat-A terminals should be exempt from these limits for an indefinite period.

II. <u>Discussion</u>

A. COMSAT is Willing to Do All that is Reasonably Possible to Ensure the <u>Safety of Satellite Radionavigation Systems.</u>

COMSAT first wishes to state unequivocally that it will do all that is reasonably possible to ensure the safety of the satellite radionavigation systems in question. COMSAT along with Inmarsat has a long history of providing important safety-related services to its customers, and it understands the need for reliable, interference-free safety systems. Indeed, Inmarsat was founded in part to provide a reliable, all-weather safety communications system for ships at sea, and it continues to provide such services today in the form of, for example, the Global Maritime Distress and Safety Systems ("GMDSS"). COMSAT understands fully that safety-of-life matters are directly implicated by GPS and GLONASS, and we are committed to providing these systems with the greatest degree of protection from interference that is reasonably possible. All recommendations made in these comments have taken this position into consideration, and COMSAT is fully confident that none of the recommendations made herein will in any way pose a threat to the accuracy, safety, or reliability of the GPS and GLONASS systems.

B. COMSAT Agrees That NTIA's Proposals for the Protection of GPS are Appropriate

As an initial matter, COMSAT has no objection to adoption of NTIA's proposal for the protection of GPS. NTIA has proposed that METs operating in the band 1610-1660.5 MHz conform to OOB limits of -70 dBW/MHz for wide band signals in the band 1559-1580.42 MHz, and to -80 dBW for narrow band signals in the band 1559-1585.42 MHz. All of Inmarsat's METs tested to date will meet these OOB emission standards with no difficulty, and COMSAT supports modification of the Commission's rules to incorporate these limits for the protection of GPS.

C. NTIA's Proposals for the Protection of GLONASS Should be Modified to Allow for the Operation of Certain Inmarsat Terminals

Although NTIA's proposed limits for the protection of GPS will have few if any implications for Inmarsat's METs, the issue is not as clear when dealing with NTIA's proposals for the protection of GLONASS. While the time-phased approach outlined in NTIA's GLONASS proposal is apparently "acceptable" to Globalstar, COMSAT notes that Globalstar -- along with Iridium and the other Big LEO systems -- is not yet an operational system and does not yet have METs in the field. Thus, Globalstar and the other Big LEO systems have the benefit of being able to agree prospectively to OOB emission limits and to design and construct their METs specifically to meet such limits before the METs ever see operational use. Inmarsat, and thus COMSAT, does not have this luxury. There are currently approximately 100,000 Inmarsat terminals in use throughout the world, and each of these terminals represents a significant long-term investment on the part of the customer. Additionally there are many different models of each terminal, manufactured by a large number of companies. For example, there are approximately 15 different companies that have manufactured Standard-A terminals, some of whom have since gone out of business. Thus, the logistical and operational difficulties faced by COMSAT and Inmarsat are far more complex than they are for companies such as Globalstar, whose terminals can be built from the ground up to comply with NTIA's proposed limits. With this in mind, COMSAT recommends that the Commission adopt several modifications to the proposals set forth in NTIA's Petition.

1. **Maritime Mobile Terminals Should Be Excluded From the Proposed Limits for the Protection of GLONASS**

There are no compelling technical reasons that NTIA's proposed limits for the protection of GLONASS should apply to *maritime*-based mobile terminals. NTIA's interference model is based upon RTCA's assumption of a minimum vertical separation distance for an MET located on terrain of 100 foot height directly underneath an aircraft flying at 200 feet above the runway.[5] For this reason, the focus of NTIA's concern has surely been land mobile terminals operating in the immediate vicinity of airport runways, not maritime-based terminals. For airports not located immediately adjacent to a navigable waterway, maritime terminals obviously pose no interference problem for approaching aircraft. Even for airports where the end of a runway abuts a navigable waterway, the chance that a ship or boat operating an MET -- at sea level, *lower* than the level of the runway -- could cause interference is extremely remote. The MET's antenna would have to be on the azimuth of the approach path, at about 80 feet above sea level, with the main antenna beam pointed directly at zenith.[6] Maritime terminals -- which comprise approximately 50 percent of all Inmarsat terminals -- should therefore be excluded from any GLONASS protection limits incorporated by the Commission.

If the Government still has concerns about maritime METs operating near the vicinity of airports which are adjacent to navigable waters, an operational Rule could be imposed to prohibit L-band transmissions at a radius of a certain distance from the runways. That distance can be

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[5] RTCA, Inc. Report "Assessment of Radio Frequency Interference Relevant to the GNSS," Document No. RTCA/DO-235, January 27, 1997.

[6] A zenith pointing angle to Inmarsat-3 satellites would apply only to a ship operating on the equator, located at the sub-satellite point (at the longitude of the satellite).

taken to ensure that free space path losses would attenuate spurious emissions to levels well below the NTIA proposed spurious emission limits. Notation of such a Rule could be made, for example, on nautical charts and/or on navigational markers in the area.

In the event that the Commission chooses not to incorporate a broad exclusion from the GLONASS limits for maritime terminals, it should at least exclude maritime Inmarsat-A terminals from such limits for a number of reasons. First, Inmarsat-A terminals use a highly directional, parabolic dish antenna, with an aperture of approximately one meter and a gain of 21 dBi. The Inmarsat-As operate at elevation angles at or above five degrees. Because of the high-gain -- totally unlike portable or hand-held terminals -- the antenna must be capable of being steered in the direction of the GSO (Inmarsat) satellite, with sufficient pointing accuracy to ensure that the G/T and EIRP requirements are satisfied continuously under ship operating conditions (including ship roll [+/-30 deg], pitch [+/-10 deg], yaw [+/-8 deg], surge [+/-0.2g], sway [+/-0.2g], heave [+/-0.5g], turning rate [6 deg/s] and headway [30 knots]). This means automatic tracking of the satellite beacon is required. In addition, Inmarsat-A specs require that all transmissions from the SES "shall be inhibited wherever the antenna is pointed away from the satellite intentionally, for example whenever a "cable-unwrap" procedure is invoked."

These technical details indicate that even in the case of Inmarsat-A equipped ships operating in the vicinity of "near-ocean" located airports, approaching civil aircraft with GPS+GLONASS navigational equipment would <u>not</u> be exposed to spurious emission emitted by the main-beam of an Inmarsat-A ship terminal. In all likelihood, such aircraft would only "see" spurious signals emitted through the sidelobes of the Inmarsat-A SES. The Inmarsat-A antennas have a (sidelobe) radiation pattern which follows a 41-25*LOG(theta) roll-off gain response.

Therefore, while Standard-A main-beam gain would exceed 21 dBi, the gain at, for example, 25 degrees off bore sight would be only 6 dBi, which is a full 15 dB lower than peak bore-sight gain. In this case, the EIRP density of spurious emissions from the ship terminal illuminating the aircraft would be 32 times lower than the expected spurious signals radiated by the main beam.

Finally, and perhaps most importantly from the practical standpoint of imposing the proposed OOB spurious emission standard by January 1, 2005, Inmarsat is seeing a net decrease in the population of all Inmarsat-A terminals (land and ship). The average decrease in Inmarsat-A commissionings in 1997 has been 47 terminals per month. Inmarsat forecasts that the current number of commissioned Inmarsat-A terminals -- 25,093 -- will be reduced by 15-20 percent by the end of 2000 and by 65-70 percent by the end of 2005. Since the availability of commercial production of Inmarsat-B terminals, ship owners are opting for B in lieu of new A installations for a variety of reasons, such as high-speed data capability, lower per minute tariffs, and the fact that the Inmarsat-B makes use of same above-decks RF/antenna equipment as Inmarsat-A (which is an attractive feature when upgrading ships with existing Inmarsat-A terminals). COMSAT also notes that a very high percentage of the shipboard A terminals are used by the U.S. Navy, U.S. Coast Guard, and other U.S. Government agencies. It would be very difficult to retrofit the various vintages of Inmarsat-A with better diplexer filters, as the manufacturers have no economic incentive to build or support an improvement package for a terminal which is being phased out. As a matter of fact, Type Approval of new models of Inmarsat-A have been eliminated by

Inmarsat as of 1 July 1989.[7]

In short, COMSAT considers that spurious emissions from shipboard-A terminals--even if they do not technically comply fully with the proposed NTIA standard for GLONASS -- *do not* pose a threat to the safety or efficiency of GPS/GLONASS operations in connection with civil aviation. As such, we think these terminals should be grandfathered from any subsequent imposition of a FCC Rule embodying the NTIA out-of-band spurious emission standard for MESs.

2. Land Mobile Terminals

a. Preliminary Testing Indicates That Inmarsat's Digital Terminals Will Meet NTIA's Proposed Emission Limits

While testing continues, COMSAT has the view that the modern digital Inmarsat terminals (B, C, M, and mini-M) can meet (and in many cases exceed) the spurious emission limit proposed by the NTIA to FCC in the two frequency ranges of interest, vis-a-vis GPS L1 carrier and GLONASS. In response to NTIA's Petition, COMSAT and INMARSAT requested several

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[7] Additionally, there is a host of OOB spurious emission data collected by Inmarsat over a period of years that is based on Type Approval tests by the manufacturers. However, as explained in Section II(C)(2)(b), these Type Approval tests performed by the manufactuers were based on circa 1980 Inmarsat-A Technical Requirement Document (TRD), which called for a demonstration of spurious EIRP output down to a level of -60 dBW/4kHz. Assuming a flat spurious power density, this translates to an equivalent EIRP of -36 dBW/MHz, far less stringent that the proposed FAA value of -70 dBW/MHz. To date, manufacturers have not responded to Inmarsat's recent requests for new measurements of Inmarsat-A OOB spurious emissions, with sufficient spectrum analyzer sensitivity to discern wideband spurious products down to or below -70 dBW/MHz levels or discrete products down to a level of -80 dBW/700 Hz, or lower. As such, it would not be appropriate for COMSAT to provide the old data at this time. The task of sampling the entire fleet of Inmarsat-A terminals, with its many vintages and models (over 70 different models are Type Approved) is not manageable in the near term. Of course, as any measured data on Inmarsat-A OOB spurious becomes available, COMSAT and Inmarsat are committed to making such information available to the Commission as quickly as possible.

equipment manufacturers to conduct spectrum analyzer measurements of the OOB emissions for each INMARSAT Standard terminal. The sampling for the OOB emission measurements included 5 Inmarsat-B models, 3 Inmarsat-C models and 1 mini-M model. The OOB emission measurements were performed at ambient temperature for each of these terminals across the band 1559-1605 MHz. The following measurement bandwidths were used by different manufacturers for their OOB emissions tests: 1 MHz, 10 KHz, 3 KHz and 300 Hz (as appropriate to resolve the discrete components). Each manufacturer tested their terminals operating under appropriate modulation (i.e, BPSK or offset QPSK) and at their full rated RF power output, with the carrier frequency set to the lower, middle and upper part of the transmit band 1626.5-1660.5 MHz. The test was calibrated by each manufacturer to include the appropriate antenna gain for each Inmarsat Standard terminal in order to demonstrate the equipment performance relative to the proposed EIRP limits of -70 dBW/1 MHz and -80 dBW discrete.

Although these terminals were not specified to meet the new proposed limits, the measured data demonstrated that these Inmarsat terminals, which are currently being used, actually meet the new limits, in many cases with a substantial margin. Table 1 summarizes the test result for the different Inmarsat Standard terminal models from different equipment manufacturers. (For the column headed "Narrow Band", a 'yes' indicates that the sample measurements perform better than the limit of -80 dBW for discrete spurious emissions in the band 1559-1605 MHz. For the column headed "Wide band", a 'yes' indicates that the sample measurements perform better than the limit of -70 dBW/1 MHz for spurious emissions in the band 1559-1605 MHz.) As the table shows, the sample tests reflect the trend by the manufacturers to far exceed the Inmarsat OOB specification over this band.[8]

b. Land-Based Inmarsat-A Terminals

With regard to land-based Inmarsat-A terminal, this was the first Inmarsat "standard" employed in the Inmarsat system and was derived from the prototype terminals developed for COMSAT's MARISAT system. The MARISAT satellites were built by Hughes Aircraft to COMSAT's specifications and were first launched by Delta 2914 in 1976 and then operated for several years by COMSAT. These satellites were subsequently leased by COMSAT to the Inmarsat Consortium for use as the initial space segment after Inmarsat's formation, in 1980. Thus, the Inmarsat-A system and terminal design predated the introduction of GLONASS and as such Inmarsat did not, a priori, include in its specifications for Standard-A (now called Inmarsat-A) any special consideration of out-of-band spurious emissions impacting this (aeronautical) radionavigation service.

The Technical Requirement Document ("TRD") for Inmarsat-A did include a generic specification for "Spurious Outputs." Thus, all Inmarsat (voice) terminals, even the early vintage terminals, are configured for Full Duplex operation, which means that unwanted transmitter emissions falling within or adjacent to the MSS receive band (1525-1559 MHz) must be suppressed to a very low level in order to not degrade the MES receiver G/T performance. The typical specification for spurious outputs in the Inmarsat-A TRD called for a spurious EIRP

[8] COMSAT also notes that its "Planet-1" mini-M terminal manufactured by NEC America, Inc., has been certified as meeting the proposed OOB emissions limits. A letter to this effect was submitted by COMSAT to the Commission on July 17, 1997. NTIA has validated these measurements.

output of -60 dBW/4 kHz at frequencies above and below the transmit band. However, footnotes to this value indicate that in the frequency bands near the receiver pass band, the spurious signals must be substantially lower than specified in order to satisfy the specified G/T requirements. This TRD specified value of EIRP for spurious outputs is significantly higher (less stringent) than the FAA's proposed value of -70 dBW/MHz (by 34 dB!). However, when taking into account the need to meet the G/T requirement of the MES, the level of unwanted emissions must be at or below the thermal noise level of the receiver, KTo, a level of approximately -204 dBW/Hz (equivalent to -144 dBW/MHz) at the receiver band edge (1559 MHz). The expected spurious levels in the vicinity of the GPS L1 carrier, which is only 15 MHz higher in frequency, would be much lower (more stringent) than the -70 dBW level requested by the NTIA. Because of these design considerations (the need to isolate the terminal receiver from the transmitter), we expect the spurious performance of Inmarsat-A will be shown to be fully compliant as far as the NTIA proposed level of protection for GPS, even though the measurement data on Inmarsat-A is very fragmentary at this writing.

However, the same theory that applies to GPS cannot be applied as confidently with regard to protection of GLONASS because the GLONASS ARNS system frequency of operation lies in the band that is 30 MHz closer than GPS with respect to the Inmarsat-A terminal transmit band. Thus, it is in the nature of any MES diplexer filter that the level of filter rejection is dependent on the frequency offset from the pass-band of the filter (centered on the transmitter frequency band). Despite the lower rejection capabilities of the diplexer at the frequency of GLONASS, it may nevertheless turn out that, when more data is available, late model Inmarsat-As could approach the excellent, low-spurious performance of the Inmarsat-Bs which have recently been measured. For these reasons and the reasons discussed in Section II(C)(1), the Commission should "grandfather" all Inmarsat-A terminals from compliance with the GLONASS protection limits for an indefinite period.

III. Conclusion

For the reasons stated above, the Commission should incorporate NTIA's proposed OOB GPS emission limits, but should exclude maritime terminals from the GLONASS protection limits and should "grandfather" Inmarsat-A terminals indefinitely. COMSAT notes that it continues to test the affected Inmarsat terminals, and we will supplement the record as appropriate as new data and information become available.

Respectfully submitted,

By: ______________________

Bruce A. Henoch
COMSAT Corporation
6560 Rock Spring Drive
Bethesda, Maryland 20817
(301) 214-3347
Its Attorney

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TABLE 1

SUMMARY OF OUT-OF-BAND EMISSION TEST RESULTS FOR INMARSAT STANDARD TERMINALS

Case	Inmarsat Std	Manufacturer	Model	Transmit Frequency (MHz)	Meas. Bandwidth	Narrow Band (-80 dBW)	Wide Band (-70 dBW / 1MHz)
1	B	A	1	1646.5	10 KHz	yes	N/A
2	B	A	1	1626.5	1 MHz	N/A	yes
3	B	A	1	1646.5	1 MHz	N/A	yes
4	B	A	1	1626.5	10 KHz	yes	N/A
5	B	B	1	1636.5	3 KHz	yes	yes
6	B	B	2	1636.5	3 KHz	yes	yes
7	B	C	1	1626.5	1 MHz	N/A	Note 4
8	B	C	1	1636.5	1 MHz	N/A	yes
9	B	C	1	1646.5	1 MHz	N/A	yes
10	B	C	1	1626.5	300 Hz	yes	N/A
11	B	C	1	1636.5	300 Hz	yes	N/A
12	B	C	1	1646.5	300 Hz	yes	N/A
13	B	D	1	1626.5	1 MHz	N/A	yes
14	B	D	1	1643.5	1 MHz	N/A	yes
15	B	D	1	1660.5	1 MHz	N/A	yes
16	B	D	1	1626.5	3 KHz	yes	N/A
17	B	D	1	1643.5	3 KHz	yes	N/A
18	B	D	1	1660.5	3 KHz	yes	N/A
19	C	B	1	1636.5	3 KHz	yes	yes
20	C	B	2	1636.5	3 KHz	yes	yes
21	C	C	1	1646.5	1 MHz	N/A	yes
22	C	C	1	1636.5	1 MHz	N/A	yes
23	C	C	1	1626.5	1 MHz	N/A	yes
24	C	C	1	1626.5	300 Hz	yes	N/A
25	C	C	1	1636.5	300 Hz	yes	N/A
26	C	C	1	1646.5	300 Hz	yes	N/A
27	Mini-M	D	1	1626.5	1 MHz	N/A	yes
28	Mini-M	D	1	1643.5	1 MHz	N/A	yes
29	Mini-M	D	1	1660.5	1 MHz	N/A	yes
30	Mini-M	D	1	1626.5	3 KHz	yes	N/A
31	Mini-M	D	1	1643.5	3 KHz	yes	N/A
32	Mini-M	D	1	1660.5	3 KHz	yes	N/A

Notes:

1. For the column headed "Narrow Band", a 'yes' indicates that the sample measurements perform better than the limit of -80 dBW for discrete spurious emissions in the band 1559-1605 MHz.
2. For the column headed "Wide band", a 'yes' indicates that the sample measurements perform better than the limit of -70 dBW/ 1 MHz for spurious emissions in the band 1559-1605 MHz.
3. N/A indicates the result is not applicable to the measured bandwidth as performed by the respective manufacturer.
4. The limit is exceeded by 2-3 dB around the band 1604-1605 MHz when the MET is transmitting at the lowest carrier frequency of 1626.5 MHz.